



INVESTOR IN PEOPLE

The Patent Office
 Concept House
 Cardiff Road
 Newport
 South Wales
 NP10 8QQ

REC'D. 07 DEC

WIPO

**PRIORITY
 DOCUMENT**
 SUBMITTED OR TRANSMITTED IN
 COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 22 November 2004

BEST AVAILABLE COPY

17NOV03 E852396-9 000192
P01/7700 0.00-0326608.7



Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference

N.90171 JGL

2. Patent application number

(The Patent Office will fill this part in)

14 NOV 2003

0326608.7

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Intelligent Engineering (Bahamas) Limited
Bahamas International Trust Building
Bank Lane
PO Box N8188

Patents ADP number (*if you know it*) 07775000002

If the applicant is a corporate body, give the country/state of its incorporation

Bahamas

4. Title of the invention

Improved Structural Sandwich Plate Members With Forms

5. Name of your agent (*if you have one*)

J. A. KEMP & CO.

"Address for service" in the United Kingdom to which all correspondence should be sent (*including the postcode*)

14 South Square
Gray's Inn
London
WC1R 5JJ

Patents ADP number (*if you know it*)

00000026001

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country

Priority application number
(*if you know it*)

Date of filing
(*day / month / year*)

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application

Date of filing
(*day / month / year*)

8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?

Answer YES if:

- a) any applicant named in part 3 is not an inventor, or
- b) there is an inventor who is not named as an applicant, or
- c) any named applicant is a corporate body.

Otherwise answer NO (See note d)

Yes

Patents Form 1/77

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation/sheets of this form

Description 7

Claim(s) 3

Abstract 1

Drawing(s) 3 

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for a preliminary examination and search (Patents Form 9/77) 1

Request for a substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature(s)


J.A. KEMP & CO.

Date 7 November 2003

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

J G LEEMING
020 7405 3292

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

- a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
b) Write your answers in capital letters using black ink or you may type them.

IMPROVED STRUCTURAL SANDWICH PLATE MEMBERS WITH FORMS

The present invention relates to structural sandwich plate members which comprise
5 two outer plates and a core of plastics or polymer material bonded to the outer plates with
sufficient strength to substantially contribute to the structural strength of the member.

Structural sandwich plate members are described in US 5,778,813 and US 6,050,208,
which documents are hereby incorporated by reference, and comprise outer metal, e.g.
steel, plates bonded together with an intermediate elastomer core, e.g. of unfoamed
10 polyurethane. These sandwich plate systems may be used in many forms of construction
to replace stiffened steel plates or formed steel plates and greatly simplify the resultant
structures, improving strength and structural performance (e.g. stiffness, damping
characteristics) while saving weight. Further developments of these structural sandwich
plate members are described in WO 01/32414, also incorporated hereby by reference. As
15 described therein, foam forms may be incorporated in the core layer to reduce weight and
transverse metal sheer plates may be added to improve stiffness.

According to the teachings of WO 01/32414 the foam forms can be either hollow
or solid. Hollow forms generate a greater weight reduction and are therefore advantageous.
The forms described in that document are not confined to being made of light weight foam
20 material and can also be made of other materials such as wood or steel boxes.

International Patent Application WO 02/078948 is a further development of the
concept of including hollow forms and describes forms that are easy to manufacture and
assemble, in particular hollow elongate forms made from snap-together pieces are
described. GB 2 374 038 A, priority from which is claimed in WO 02/078948, suggests the
25 use of spherical members but without giving any practical details, e.g. sizes or materials for
the spheres.

In WO 01/32414 and WO 02/078948 the elongate forms are sized according to the
plate member being made. Thus, the techniques disclosed in these two documents are most
applicable where a large number of identical plate members are to be made so that the
30 forms can be economically mass-produced, e.g. by moulding. If a small number of plates of
a given size or shape are to be made, the forms will need to be handmade or adapted at
relatively great expense.

It is an aim of the present invention to provide structural sandwich plate members with forms that can be readily adapted to different sizes and/or shapes of plate.

According to the present invention, there is provided a structural sandwich plate member comprising: first and second outer plates; a core of plastics or polymer material
5 bonded to said outer plates with sufficient strength to transfer shear forces therebetween; and a plurality of lightweight forms within the core, wherein said forms do not tessellate in a plane parallel to said outer metal layers and have principal dimensions in the range of from 20 to 200% of the distance between said outer metal layers.

The term "principal dimensions" is intended to refer to the diameter of a sphere, the
10 major and minor diameters of an ovoid, the length, depth and breadth of a cuboid, etc.. In the case of irregular shapes, the principal dimensions may be regarded as the dimensions of the smallest rectangular box in which the shape will fit.

By using forms that are comparable in dimensions to the gap between the metal layers, and hence relatively small compared to the lateral dimension (length and/or width)
15 of the plate member, any shape of plate can be manufactured using standard mass-produced forms, without the need for hand adaptation. The exact shape of the form is not crucial in many cases, though additional advantages can be obtained with specific shapes. It is required that the forms do not tessellate so that there are spaces between them for the core material which bonds to the outer plates. The shape and arrangement of the forms can be
20 varied to vary the proportion of the volume between the outer plates that is occupied by core material.

The forms may be arranged in a single layer or multiple layers. In the case of multiple layers, it is preferred in some applications that the forms of one layer directly
25 overlie the forms of the layer below so that there are parts of the core material extending perpendicularly between the outer metal layers. Where there are multiple layers of forms, an interlayer may be provided between the layers of forms. The layer may be made of a high tensile strength material such as metal, a high tensile strength fabric, such as

~~flexible film or fibrous film, fiber reinforced plastic, other suitable fabric, mesh or ceramic~~

~~or other material having sufficient strength to transfer shear forces between the outer metal layers.~~

~~The forms may be arranged in a single layer or multiple layers. In the case of multiple layers, it is preferred in some applications that the forms of one layer directly~~

~~overlie the forms of the layer below so that there are parts of the core material extending perpendicularly between the outer metal layers. Where there are multiple layers of forms, an interlayer may be provided between the layers of forms. The layer may be made of a high tensile strength material such as metal, a high tensile strength fabric, such as~~

~~flexible film or fibrous film, fiber reinforced plastic, other suitable fabric, mesh or ceramic or other material having sufficient strength to transfer shear forces between the outer metal layers.~~

relative positions of the forms in different layers - and thereby enhance the performance of the plate member.

A particularly preferred form is a spherical hollow ball having a diameter substantially equal to $1/N$ of the distance between said outer metal layers, N being a natural number between 1 and 5. The balls may for example have a diameter in the range of from 20 to 100mm and can be used in single or multiple layers in plate members with core thicknesses in the range of from 20 to 100mm. Balls made of polypropylene are particularly suitable and may be solid or preferably hollow with a solid skin. Solid balls provide less weight reduction but may still be advantageous as they are cheaper than the elastomers preferred as the core material. Such balls are widely available and cheap to manufacture.

The forms may also be provided with a plurality of protrusions so as to increase the spacing between the forms, and hence the proportion of the core cavity occupied by core material. The protrusions may also be arranged to determine the relative shapes and positions adopted by adjacent forms and hence the shape of the void space that is filled by core material, e.g. to ensure a continuous mass of core material.

A mesh, e.g. of wire, may be used to assist the placing of the forms and space them apart from each other and/or from the metal layers.

The materials, dimensions and general properties of the outer plates of the structural sandwich plate member of the invention may be chosen as desired for the particular use to which the structural sandwich plate member is to be put and in general may be as described in US-5,778,813 and US-6,050,208. Steel or stainless steel is commonly used in thicknesses of 0.5 to 20mm and aluminium may be used where light weight is desirable. Aluminium in general may be used in thicknesses 2 to 4 times that of steel, i.e. 1 to 50mm, to give comparable strength. Similarly, the plastics or polymer core may be any suitable material, for example an elastomer such as polyurethane, as described in US-5,778,813 and US-6,050,208.

Further, the invention provides a method of manufacturing a structural sandwich plate member comprising the steps of: providing first and second outer plates in a spaced-apart relationship and a plurality of lightweight forms within the space between said plates, wherein said forms do not tessellate in a plane parallel to said outer metal layers and have principal dimensions in the range of from 20 to 200% of the distance between said outer

metal layers; injecting uncured plastics or polymer material to fill the space defined between said outer plates and around said plurality of forms; and allowing said plastics or polymer material to cure to bond said outer plates together with sufficient strength to transfer shear forces therebetween.

5

The present invention will be described below with reference to exemplary embodiments and the accompanying schematic drawings, in which:

Figure 1 is a cross-sectional view of a structural sandwich plate member according to a first embodiment of the present invention;

10

Figure 2 is a cross-sectional view of the structural sandwich plate member of Figure 1 along the line A-A;

Figure 3 is a cross-sectional view similar to Figure 2 of a structural sandwich plate member according to a variant of the first embodiment of the present invention;

15

Figure 4 is a cross-sectional view of a structural sandwich plate member according to a second embodiment of the present invention;

Figure 5 is a cross-sectional view of a structural sandwich plate member according to a third embodiment of the present invention;

Figure 6 is a cross-sectional view of a structural sandwich plate member according to a fourth embodiment of the present invention; and

20

Figure 7 is a cross-sectional view of a structural sandwich plate member according to a fifth embodiment of the present invention;

In the various drawings, like parts are indicated by like reference numerals.

25 The structural sandwich plate member shown in Figure 1 comprises upper and lower outer plates (face plates) 11, 12 which may be of steel (e.g. of thickness in the range of from 0.5 to 20mm) or aluminium (e.g. of thickness in the range of 1 to 50mm). Edge plates (not shown) are welded between the face plates 11, 12 around their outer peripheries to form a closed section. Alternatively, the plate member may be assembled in a mould

sufficient strength and has sufficient mechanical properties to transfer shear forces expected in use between the two face plates. It is preferably compact. The bond strength between the core 13 and face plates 11, 12 should be greater than 3MPa, preferably 6MPa, and the modulus of elasticity of the core material should be greater than 200MPa, preferably 250MPa. A lower modulus may be used where high temperature conditions will not be experienced. For low load applications, such as floor panels, where the typical use and occupancy loads are of the order of 1.4kPa to 7.2kPa, the bond strength may be lower, e.g. approximately 1MPa. By virtue of the core layer, the structural sandwich plate member has a strength and load bearing capacity of a stiffened steel plate having a substantially greater plate thickness and significant additional stiffening. The plate, of course, need not be flat but may take any form required for its intended use.

To reduce the weight of the plate member, a plurality of lightweight forms 14 are provided in the core. In this embodiment, the forms 14 comprise hollow, solid skin polypropylene balls having a diameter substantially equal to the distance D between the outer plates 11, 12. As shown in Figure 2, which is a cross-section along the line A-A in Figure 1, the balls 14 are arranged in orthogonal rows and columns so that substantial gaps are left between them. This arrangement of forms is particularly appropriate where the major loads in use are directed along the lateral and longitudinal directions, indicated by arrows in Figure 2. These gaps fill with core material which bonds the outer metal plates together. Because of the curvature of the balls, the core material forms column-like structures extending directly between the outer plates and bonded to the plates over a wide area. Thus the bond strength compared to a solid core is reduced by no more than about 5% and the shear transfer capability is maintained.

The balls 14 may also be closely packed in a hexagonal array, as shown in Figure 3. This results in a lighter plate member 20 as the proportion of the core cavity that is occupied by the core material 133 is reduced. The plate member is also particularly suited to applications in which the major loads will lie on oblique directions, as indicated by arrows in Figure 3.

To manufacture the structural sandwich plate member 10, the edge plates are welded around the periphery of lower faceplate 12 and then the balls 14 are placed in the resulting open cavity. At this stage, any precast sections of the core may be put in place as well as any shear plates or other fittings that may be desired. Then, the upper faceplate 11

is welded to the edge plates to form a closed cavity and the plastics or polymer material injected to form core 13. The injected material is then allowed to cure and the injection ports used in the injection step ground off and sealed along with the vent holes. These steps may be performed in situ, or off-site in factory conditions and the finished panel transported to the installation site. Prior to the injection of the core, the balls 13 help to support the upper faceplate 11 so that larger plate members may be manufactured without sagging and without the need for internal supports.

A second embodiment of the present invention is shown in Figure 4. The structural sandwich plate member 30 according to the second embodiment of the invention is similar to the first embodiment but includes two layers of balls 14. This enables a thicker plate member to be made without increasing the spacing of the column-like structures of the core. Preferably, as shown, the balls of one layer overly the balls of the other layer but in lower load applications the balls may be close packed in the vertical direction as well as in the horizontal direction. Of course three or more layers of forms may be provided and the different layers of forms need not all be the same, however it is preferred that there are 5 or fewer layers.

Figure 5 illustrates a third embodiment of the present invention. This includes a mesh 15 above and below the layers of balls to space them away from the outer metal plates to increase the bond area between core and the plates. The presence of a solid layer of core material adjacent the metal plates 11,12 also improves curing and ensures a more uniform impact resistance across the area of the plate member. The mesh may be a simple wire mesh that is moulded by hand to the desired shape. Mesh may also be provided between layers of balls and may serve to assist placement of the balls and to space them apart from each other.

A fourth embodiment of the invention is shown in Figure 6. In addition to the two layers of forms 14, as provided in the second embodiment, the plate member 50 of the fourth embodiment includes an interlayer 19 provided between the layers of forms. The interlayer 19 may be a layer of plastic or other material which is injected into the cavity between the layers of forms 14 and cured. The interlayer 19 may also be a layer of plastic or other material which is injected into the cavity between the layers of forms 14 and cured. The interlayer 19 may also be a layer of plastic or other material which is injected into the cavity between the layers of forms 14 and cured. The interlayer 19 may also be a layer of plastic or other material which is injected into the cavity between the layers of forms 14 and cured.

application number (Agent's ref N88882) entitled "IMPROVED
STRUCTURAL SANDWICH PLATE MEMBERS" and filed in the name of the present
applicant and on the same day as this application. The interlayer may also be shaped so as
to assist or determine the placing of the forms - e.g. their spacing, orientation or the relative
5 positions of the different layers - and if that is the sole purpose of the interlayer it may be
made of the same material as the core or a cheaper material, especially if a mesh.

An alternative approach to increasing the spacing between the balls, is to provide
them with projections, as shown in Figure 7. This shows plate member 60 according to a
fifth embodiment of the invention, which is generally the same as the first embodiment,
10 save that the balls 16 are provided with a plurality of projections 18 around their surfaces.
The projections 18 serve to increase the ball to ball spacing as well as the ball to metal plate
spacing, increasing the bond strength of the core to the metal plates and the shear transfer
capacity.

Depending on the intended use of the plate member, various of its properties may
15 be enhanced by the use of different materials for the lightweight forms 14,16 and by the
provision of different fillings for the forms. For example, the forms 14, 16 may be made of
metal, ceramic, Kevlar or other high-strength materials to increase the blast and ballistic
resistance of the plate member and also to improve shrapnel capture and fragmentation
resistance. This may provide particular advantages if an interlayer as described above is
20 also provided for increased blast and ballistics resistance. To increase fire resistance, the
forms may also be made of metal or ceramic and may be filled with inert or fire-retardant
materials. Other gas or liquid fillings may also be used to improve the acoustic and/or
thermal insulation properties of the metal plate. The forms may for the same reason be
evacuated.

25

It will be appreciated that the above description is not intended to be limiting and
that other modifications and variations fall within the scope of the present invention,
which is defined by the appended claims. For example, whilst in the described
embodiments all the forms are the same, it will be appreciated that mixtures of different
30 shapes and/or sizes of form may also be used.

CLAIMS

1. A structural sandwich plate member comprising:
5 first and second outer plates;
a core of plastics or polymer material bonded to said outer plates with sufficient strength to transfer shear forces therebetween; and
a plurality of lightweight forms within the core, wherein said forms do not tessellate in a plane parallel to said outer metal layers and have principal dimensions in the range of
10 from 20 to 200% of the distance between said outer metal layers.
2. A structural sandwich plate member according to claim 1 wherein said lightweight forms are arranged in a single layer.
- 15 3. A structural sandwich plate member according to claim 1 wherein said lightweight forms are arranged in multiple layers.
4. A structural sandwich plate member according to claim 3 further comprising an interlayer between two of said multiple layers of forms.
20
5. A structural sandwich plate member according to claim 3 or 4 wherein the forms of one layer directly overly the forms of the layer below so that there are parts of the core material extending directly between the outer metal layers.
- 25 6. A structural sandwich plate member according to any one of the preceding claims wherein said lightweight forms are hollow.

8. A structural sandwich plate member according to claim 7 wherein said forms have a diameter substantially equal to $1/N$ of the distance between said outer metal layers, N being an integer in the range of from 1 to 5.
- 5 9. A structural sandwich plate member according to claim 7 or 8 wherein said forms have a diameter in the range of from 20 to 100mm
10. A structural sandwich plate member according to claim 6, 7, 8 or 9 wherein said forms are made of polypropylene and have a solid skin.
- 10 11. A structural sandwich plate member according to any one of claims 1 to 9 wherein said forms are made of metal, ceramic, or a high tensile strength fabric, such as Kevlar(TM) or Spectra(TM).
- 15 12. A structural sandwich plate member according to any one of the preceding claims wherein said forms have a plurality of protrusions so as to increase the spacing between them, and hence the proportion of the core cavity occupied by core material.
13. A structural sandwich plate member according to any one of the preceding claims
20 wherein said forms are filled with an inert gas, a fire retardant substance, a thermal or acoustic insulating fluid or a partial vacuum.
14. A structural sandwich plate member according to any one of the preceding claims
25 further comprising a mesh, e.g of wire, to assist the placing of the forms and space them apart from each other and/or from the metal layers.
15. A method of manufacturing a structural sandwich plate member comprising the steps of: providing first and second outer plates in a spaced-apart relationship and a plurality of lightweight forms within the space between said plates, wherein said forms do
30 not tessellate in a plane parallel to said outer metal layers and have principle dimensions in the range of from 20 to 200% of the distance between said plates; injecting uncured plastics or polymer material to fill the space defined between said outer plates and around said

plurality of forms; and allowing said plastics or polymer material to cure to bond said outer plates together with sufficient strength to transfer shear forces therebetween.

13. A structural sandwich plate member constructed substantially as hereinbefore
5 described with reference to the accompanying drawings.

14. A method of manufacturing a structural sandwich plate member substantially as
hereinbefore described with reference to the accompanying drawings.

ABSTRACT

IMPROVED STRUCTURAL SANDWICH PLATE MEMBERS WITH FORMS

5

A structural sandwich plate member is provided with a plurality of lightweight forms within the space between the outer plates. The forms do not tessellate and have principal dimensions in the range of from 20 to 200% of the distance between the outer plates.

10

Fig.1 .

1/3

Fig. 1

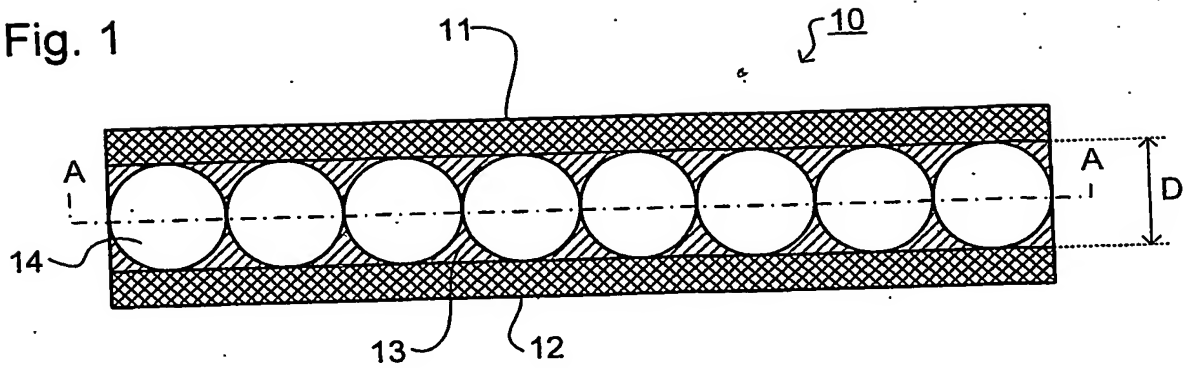


Fig. 2

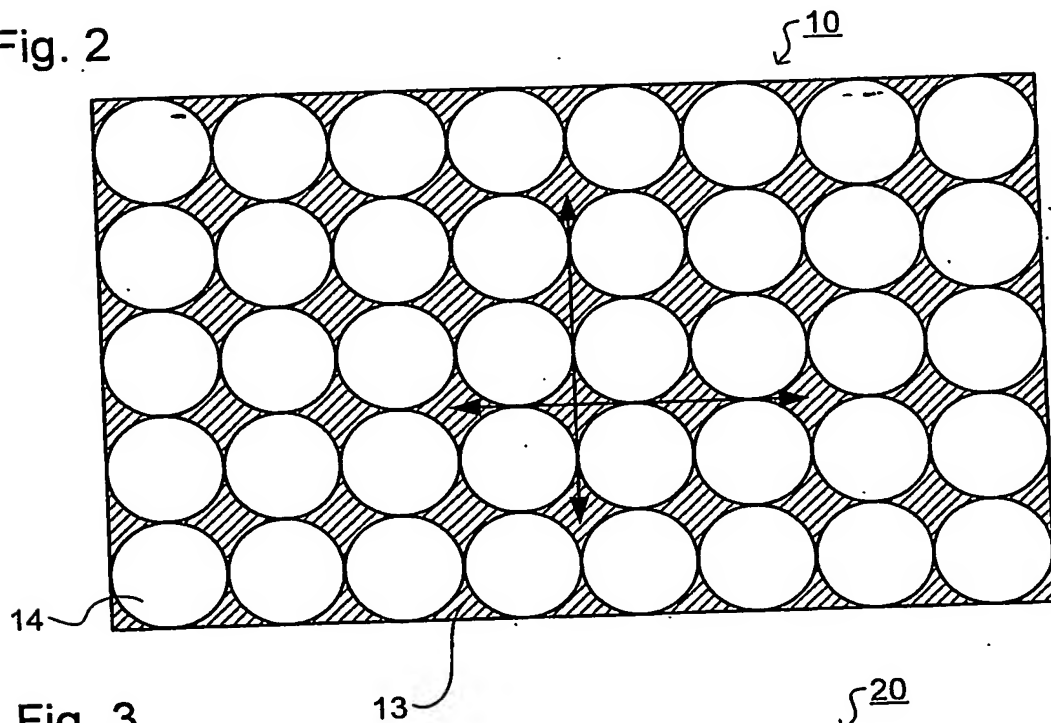


Fig. 3

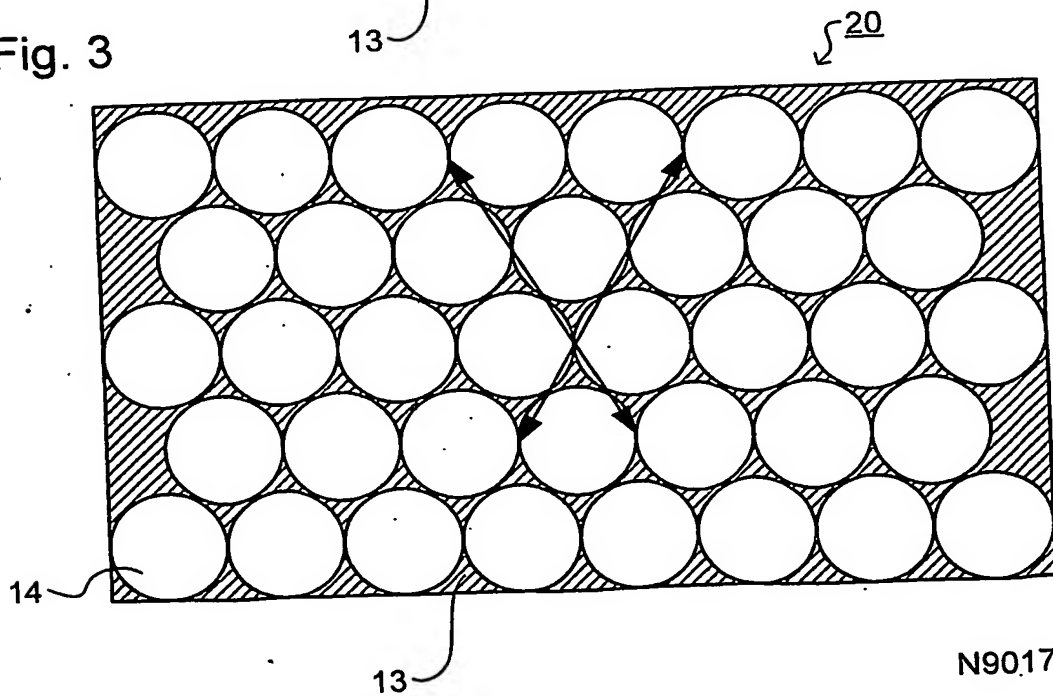


Fig. 4

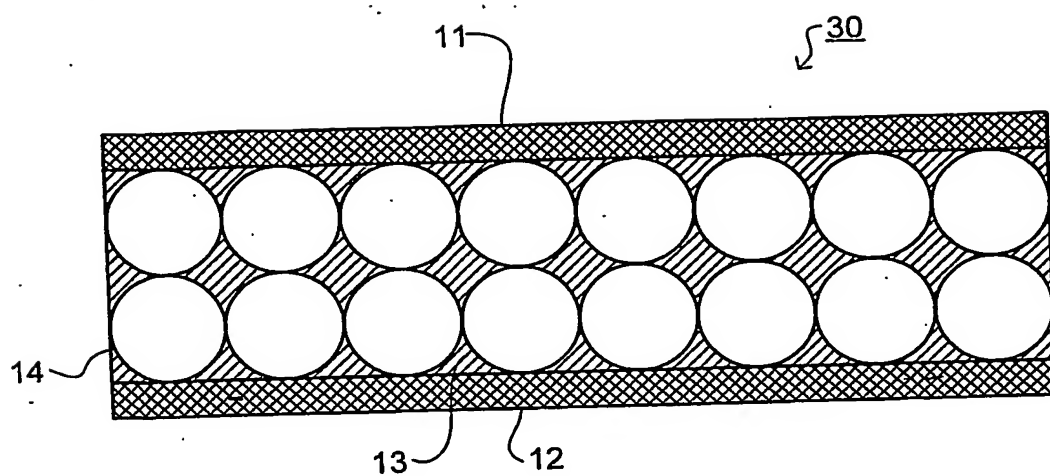


Fig. 5

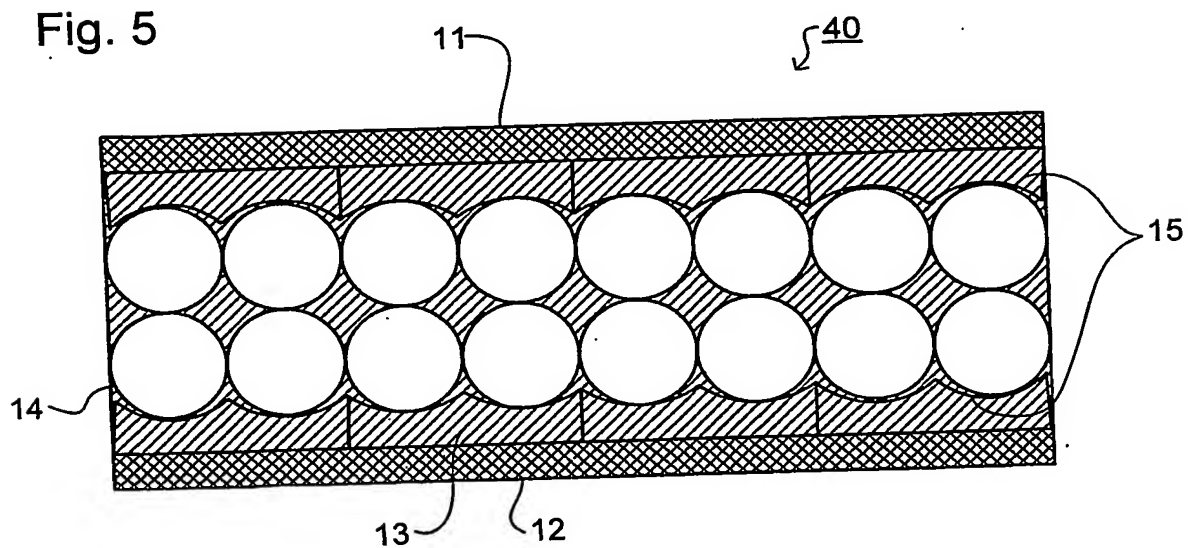


Fig. 6

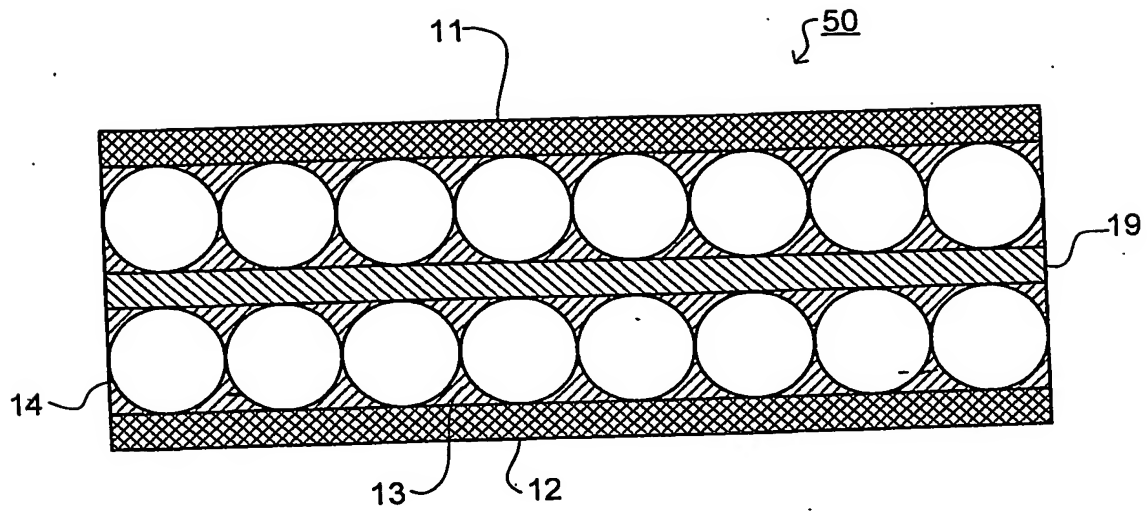
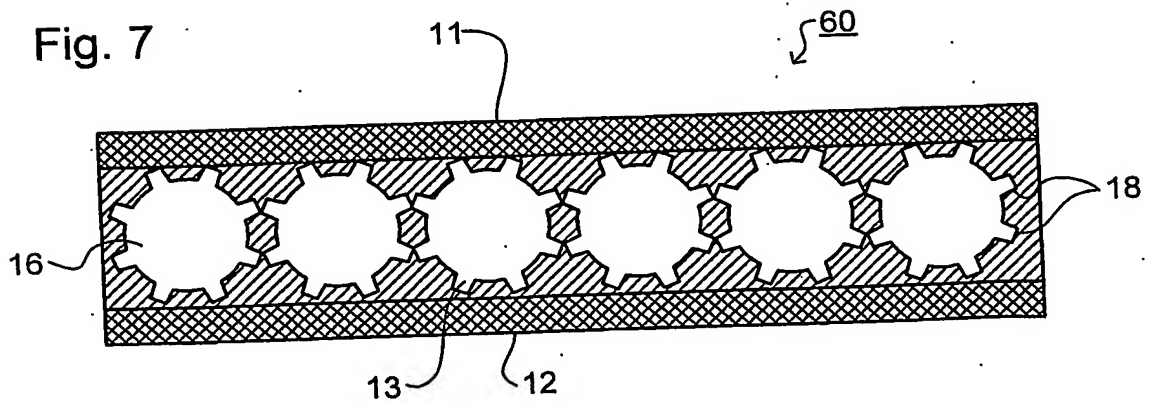


Fig. 7



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☒ BLACK BORDERS

☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES

☐ FADED TEXT OR DRAWING

☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING

☐ SKEWED/SLANTED IMAGES

☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS

☐ GRAY SCALE DOCUMENTS

☒ LINES OR MARKS ON ORIGINAL DOCUMENT

☒ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY

☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.